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Article

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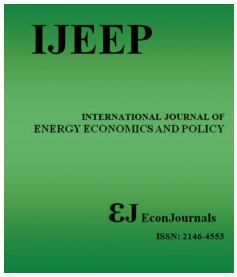
International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Akbar, Leon/Izza Mafruhah et. al. (2024). Determinants of variables that affect electrical energy consumption in Indonesia 2011-2020. In: International Journal of Energy Economics and Policy 14 (1), S. 165 - 171. https://www.econjournals.com/index.php/ijeep/article/download/11069/7659/35605. doi:10.32479/ijeep.11069.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2024, 14(1), 165-171.

Determinants of Variables That Affect Electrical Energy Consumption in Indonesia 2011-2020

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Received: 28 April 2023 **Accepted:** 15 November 2023 **DOI:** https://doi.org/10.32479/ijeep.11069

ABSTRACT

This study aims to analyze the determinants of variables that affect electricity consumption in Indonesia 2011-2020. There are 4 variables that are used as determinant variables, namely (1) economic growth, (2) population growth, (3) human development index (HDI), and (4) internet access. This study uses a random effect model regression method using data that is panel data consisting of 34 provinces in Indonesia in the span of 2011-2020. Secondary data were obtained from the Central Statistics Agency (BPS), a statistical report of PT. PLN (Persero) and previous research literature studies. The results of this study found that (1) the variable of economic growth did not affect electricity consumption, (2) the population growth variable also did not affect the consumption of electricity, (3) the variable HDI had a positive effect on electricity consumption and (4) internet access variable has a negative effect on electricity consumption. Suggestions that the author can convey are: (1) optimizing the potential of New Renewable Energy (EBT), (2) conserving electricity and making efficient use of electricity, (3) increasing the electrification ratio so that electricity can be enjoyed by the entire community.

Keywords: Electrical Energy, Variable Determinants, Random Effect Model
JEL Classifications: P48, Q43, Q56

1. INTRODUCTION

Energy is the backbone of economic development and social welfare, both for running the economy and for consumption and daily activities. Energy plays a key role in job creation, agriculture, transportation, trade and economic development. Energy is also the main tool for eliminating poverty and sustaining human development and all forms of energy contribute to economic growth (Karekezi et al., 2012). Currently there are many types of energy which are divided into 2, namely renewable and unrenewable. However, in everyday life the energy consumption used is still unrenewable energy, one of which is electrical energy. Chen (2018) states that a greater consumption of electrical energy will affect business and industrial activities that are increasingly developing and this will support economic growth. The higher use of electrical energy encourages electricity providers to explore in order to increase the electrification ratio.

The existence of this exploration means that later on, electrical energy will be depleted because it is unrenewable resources. In fact, the form of renewable energy is important to secure the future from a scarcity of electrical energy. Not only is production dependent on energy, but it is also very important for sustainable economic growth which can only be possible with an adequate and sustainable supply of energy. As it is known, to support activities in life really requires energy. A report from the Ministry of Energy and Mineral Resources (ESDM) in 2018, the electrification ratio in Indonesia has touched 98.3%. The electrification ratio is the ratio of the calculation of the electrical energy connected in each area. The electrification ratio of 98.3% means that the electricity has been distributed at this rate so that the government, in this case PT. PLN (Persero) just needs to catch up with the shortfall of 1.7% so that Indonesia's electrification ratio becomes 100%, which means that electricity can be felt in every region.

Indonesia is one of the countries with a fairly high level of electricity consumption. According to the Global Tracking Framework Report released in Vienna, Austria states that Indonesia ranks 12 for the country with the largest electricity consumption in the world. In line with this report, BPS reports that the level of electricity consumption in 2011-2018 annually has increased by 0.06%. Electricity, which is an unrenewable source, needs to be diverted to New and Renewable Energy (EBT), considering that the increase in electricity consumption is accompanied by an increase in population. In the context of developing New and Renewable Energy (EBT) in Indonesia itself, it still faces several obstacles such as the lack of adequate infrastructure and superstructure so that it cannot be implemented. The grand design of this EBT development already exists, but implementation in the field is still not fast because there are obstacles related to technology, funding and availability of raw materials.

The data above shows that the consumption of electrical energy in Indonesia has increased every year. It can be seen from 2011 to 2018, the average increase in electricity consumption in Indonesia was 0.06%. Salahuddin and Alam (2015) stated that there is a relationship between energy and Gross Domestic Product (GDP), which means that fast or not economic growth depends on energy which is a stimulus for economic growth. Electrical energy, which is a stimulus for economic growth, needs to be fully utilized. Based on the 2016-2050 National Energy General Plan (RUEN), Indonesia is only able to utilize 8,215.6 MW of the total potential of 801,311 MW. When the use of electric energy is still not optimal, one of the objectives of the national energy policy, namely realizing energy independence and national energy security to support sustainable national development cannot be realized.

There are several factors that cause the high consumption of electrical energy, especially in Indonesia, including the rate of economic growth. It cannot be denied that the support for economic activity is electrical energy, so it is not surprising that the rate of economic growth is the thing that affects the level of consumption of electrical energy. It was also found that economic and population growth can affect the amount of electricity consumption (Basyiran, 2017). Based on data released by BPS, from 2011 to 2015 there was a decline in economic performance to its lowest point of 4.79%. After that, the Indonesian economy showed better performance and this was evidenced by an increase in the economic rate up to 2018 of 5.06%. In the phase of acceleration in the economy up to 5.06%, of course, electricity consumption is not small, namely 234,617.9 GWh. Looking at the data from BPS when the economy started to crawl up, the consumption of electrical energy also increased.

Another variable that affects energy consumption is the population growth rate. (Istiqomah and Wijaya, 2005) stated that starting in 1850 energy use had doubled, while the world's population had only increased fourfold. This analogy shows that there is a relationship between the population growth rate and the consumption of electrical energy because when the population increases, the demand for electrical energy will also increase.

In addition, in 2030 Indonesia is faced with a demographic bonus which will affect the consumption of electrical energy. The demographic bonus is a situation where the number of people with productive age (aged 15-64 years) is more than the population who is not productive (aged under 15 years and over 64 years). With an increase in population, the demand for electrical energy also increases until the production stage is smaller than consumption and an energy crisis occurs. According to Pirlogea (2012), a rapid acceleration of population growth will increase the demand for natural resources, one of which is electricity. The consumption of natural resources in the form of electricity will swell in line with the rate of population growth and in the end will have an effect on the decline in electricity resources.

Another variable that affects the level of energy consumption is the quality of human resource development. One of the indicators used to see the quality of human resources is the Human Development Index (HDI). The HDI is an index that explains the results of the development of an area that can be accessed by the community such as obtaining income, health facilities, educational facilities and so on. In the calculation of the HDI, there are 3 dimensions, namely knowledge, a decent standard of living as well as a long and healthy life.

Data from the Central Bureau of Statistics show good achievements for Indonesia in developing the quality of human resources. Starting from 2011 to 2018, the HDI figure has increased regularly and in 2018 it was at 71.39. According to the Indonesia Energy Outlook report released by the Secretariat General of the National Energy Council, this HDI also has an influence on the high and low consumption of electrical energy in Indonesia. This is because when the HDI increases, the public will also care more about energy that is unrenewable resources such as electrical energy.

When discussing HDI, it means talking about the quality of human resources. Ouedraogo (2013) states that the use of good quality energy resources will increase the value of HDI. Maulida and Silvia (2016) stated that the low HDI level reflects the low level of welfare of the population and the consumption of electrical energy tends to be low considering that electrical energy is a support in the wheels of daily life. (Martínez and Ebenhack, 2008) conducted a comprehensive analysis of tar against 120 countries, divided into energy profit countries and energy export countries. For poor countries, the HDI and energy are highly correlated. For industrialized countries, high HDI values correspond to larger energy consumption patterns. (Eras et al., 2022) states that their research results show a bidirectional relationship between the HDI and the per capita electricity consumption.

Entering the era that is completely digitalized, as it is today, the consumption pattern of society has shifted. For example, making a purchase of an item only through the internet without having to come to the store. Without realizing it, the use of the internet has changed fundamental aspects of daily activities. Moreover, Information and Communication Technology (ICT) is now a significant part of household electricity consumption. Research conducted with household objects in the UK shows that computing and electronics belonging to these households simultaneously consume about 20% or 23% of their non-heating electricity usage (Coleman et al., 2012). Both ICT use and economic growth

stimulate electricity consumption in both the short- and the long run (Salahuddin and Alam, 2016).

According to data from the Central Statistics Agency (BPS), on average each year household internet access has increased by 0.12%. The increase in internet access also has an impact on the high and low consumption of electrical energy. According to (Van Heddeghem et al., 2014) communication networks, including cellular, fixed broadband and telephone networks, consumed 1.7% of total global electricity usage in 2012.

2. LITERATURE REVIEW

2.1. Energy

In the current era of industrialization, energy plays a role as the main capital in driving the sector. Energy itself is divided into 2 types, namely renewable and unrenewable energy. Renewable energy means that it can be recycled such as wood and biogas. Meanwhile, energy that is unrenewable means that it cannot be renewed, such as natural gas, petroleum and coal. Most of the energy consumed today is still unrenewable or non-renewable. Fossil fuels are able to dominate 81% of the world's primary energy and also contribute 66% of global electricity generation. The fuel used is non-renewable so it will be depleted and scarce. The data states that up to certain circumstances we will face an energy crisis Abdullah and Morley (2014). This is in line with the report of the National Energy Council (DEN) which states that in general the reserves of fossil fuel energy resources have been shown to have continued to decline from 2008 to 2013.

For example, oil reserves are projected to only meet demand for the next 12 years, counted since 2012. Meanwhile, natural gas can meet demand for the next 20 years. In addition to increasing fossil energy reserves, through Presidential Regulation No. 5 of 2006 on National Energy Policy, Indonesia's target of 15% renewable energy is an effort to reduce the use of fossil fuels considering the dwindling number. There are several alternative energies that are used as a substitute for fossil fuels such as solar power, geothermal energy, ocean waves, currents, tides and wind power. However, the existence of these resources is still constrained by several factors, namely season, length of exposure and natural conditions.

2.2. Electrical Energy

Electrical energy is one of the main energy sources for the community as a source of energy in various activities ranging from household to industrial scale. However, several remote areas in Indonesia still do not feel the benefits of this electricity. Looking at the data released by the Ministry of Energy and Mineral Resources (ESDM), the lowest electrification ratio is in East Nusa Tenggara (NTT), which is 73%. The electrification ratio is the ratio of the extent to which electricity can be distributed throughout the area. Seeing the low electrification ratio in an area results in disrupted activities because this electrical energy becomes a necessity in everyday life. Electrical energy is a dominant component in many fields, for example to drive industry and the economy Nepal and Paija (2019).

Furthermore, Chen (2018) states that the greater the consumption of electricity for a country shows that the impact on business and industrial activities is increasingly stretching so that it supports economic growth. This is in line with Bismark et al. (2016) which states that the increase in energy use is in line with economic growth.

The management of electrical energy in Indonesia is carried out by the government through PT. PLN (Persero) in accordance with the 1945 Constitution Article 33 paragraph 1 which states that production branches which are important for the state and which control the livelihoods of the public shall be controlled by the state. This is because electricity is one of the main resources used by the community so it must be managed in an integrated manner by the government. This electrical energy enters the monopoly market because it has the characteristic of being controlled by a single producer, in this case PT. PLN (Persero).

2.3. The Relationship between Economic Growth and Electrical Energy Consumption

The current economic growth in Indonesia continues to grow positively, but along with this growth a new problem faced by Indonesia has emerged, namely the rapidly increasing demand for energy. In other words, economic growth is related to the consumption of electrical energy. This is in line with the opinion (Ayres and Warr, 2009) which states that the driving force of an economy is energy, especially electrical energy. Energy production which is unable to meet demand could logically disrupt Indonesia's economic growth, but in reality this is not the case. Despite the energy deficit, economic growth must continue to grow. This is because the relationship between Indonesia's economic growth and energy consumption is uni-directional which means that economic growth will increase electricity consumption, but not vice versa. (Ameyaw et al., 2017) including the variables of electricity consumption and economic growth, the results state that there is a one-way causality of GDP for electricity consumption.

2.4. Demand Theory

Demand in the economy is a combination of the quantity of goods and the price that consumers are willing to buy at a certain price level and time. Things that affect the demand for goods are the price of these goods and income.

3. METHODOLOGY

The method is a systemic way of working to facilitate the implementation of a research activity in order to achieve the specified goals. Recognizing the importance of selecting the right method so that the sample data obtained can be processed into proper theory and analysis so as to get the right results.

The method used in this research is quantitative method. According to Sugiyono (2016), the definition of a quantitative research method is a method used when researching a particular sample or population. The sample was selected randomly, the data were collected using a research instrument, to test the hypothesis used quantitative and statistical analysis. This study uses panel data because it consists of 34 provinces in Indonesia with a time span of 2011-2018.

This method is used to determine the condition of economic growth, population growth, HDI and internet access in Indonesia

in 2011-2018. Meanwhile, this method is also used to determine whether there is a relationship between 2 or more variables that can explain and provide an analysis of the effect of the relationship between economic growth, population growth, HDI and internet access on electricity consumption in Indonesia in 2011-2020 simultaneously or partially.

3.1. Research Framework

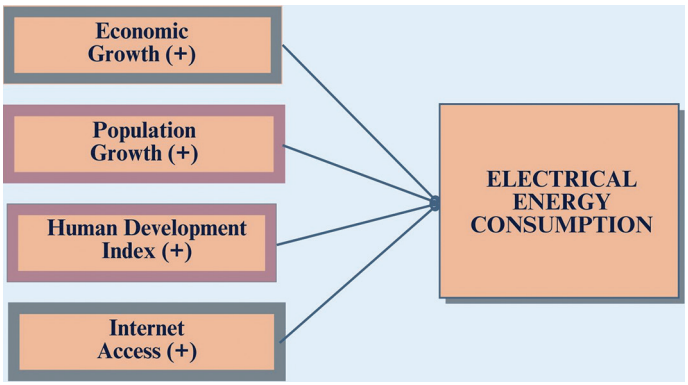
On the basis of thought and literature review results regarding previous research regarding the relationship between the independent variables (economic growth, population growth, HDI and internet access) to the dependent variable, namely the consumption of electrical energy. As explained above and has been adjusted to conditions in 34 provinces in Indonesia from 2011 to 2020, the framework in this research can be described as follows in Figure 1.

Based on the framework in Figure 1, it can be explained that (1) the variable of economic growth has a positive effect on the consumption of electrical energy. This study also shows that in the long term economic growth, industrial growth, population growth, consumption expenditure and foreign investment have an influence on electricity consumption in Indonesia (Patriamurti et al., 2021) (2) The population growth variable has a positive effect on electrical energy consumption because when the population increases, the demand for electrical energy will also increase. Population density positively impacts energy consumption for total, electricity, and fuel consumption (Muzayanah et al., 2022) (3) The HDI variable has a positive effect on the consumption of electrical energy. This is because when the HDI is high, there is a tendency for people to optimize energy consumption, especially electrical energy (Martinez and Ebenhack, 2008) and (4) Internet access variables have a positive effect on electrical energy consumption because internet access supported by ICT will consume more electrical energy. The results reveal two trends of energy consumption change: first, although ICT development increases energy consumption, energy consumption still shows an upward trend (Wang et al., 2022).

4. RESULTS AND DISCUSSION

Based on the estimation using the panel data method, it is known that the Random Effect Model (REM) is the chosen model. According to Gujarati and Porter (2009), the estimation method for the random effect panel model uses the Generalized Least Square (GLS) method, while the common effect panel model and the fixed effect panel model use the Ordinary Least Square (OLS) method. The advantage of the GLS method is that it does not need to test classical assumptions so that the random effect model method does not need to go through the classical assumption test stage. Meanwhile, the common effect and fixed effect models must test the classical assumptions.

Figure 1: Research framework



To see the magnitude of the influence of the variable economic growth, population growth, HDI and partial internet access on the consumption of electrical energy, the t test is used. Partial test or t test in the Table 1 is used to test the effect of each independent variable on the dependent variable. The results of the statistical t test in this study are as follows:

4.1. The Effect of Economic Growth on the Consumption of Electrical Energy

The number of observations in this study amounted to 265 with the number of variables as many as 5 (free and bound) and 10% alpha. To obtain t table, the formula is used:

Df = n-k; and $\alpha/2$.

Df = 265-5 = 260; and 0.1/2 = 0.05

The test results of panel data regression analysis show that the t-count for the independent variable of economic growth is 0.064274 while the t-table value with $\alpha/2$ and df = nk, df = 260 where the t-table value is 1.650735 which means that the value t-count is smaller than t-table value (0.064274 < 1.650735) and if you see the probability value of 0.9488 which is greater than 0.1 then H0 is accepted. This means that economic growth has no effect on consumption of electrical energy. According to Navarro et al. (2023), electricity consumption does not explain economic growth and vice versa. The findings further describe that expansion in trade activities and enhancement in economic growth can significantly reduce the consumption of energy through technical effect (Tiwari et al., 2022).

4.2. The Effect of Population Growth on the Consumption of Electrical Energy

It can be seen that the test results using panel data regression analysis show that the t-count for the independent variable of population growth is 0.340177, while the t-table value is 1.650735, this means that the t-count is smaller than the t-table (0, 340177 < 1.650735), besides that, it can also be seen that the probability value is 0.7340 which is greater than 0.1, so H0 is accepted. This means that population growth has no effect on energy consumption.

Table 1: t test results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	−3.357670	1.315779	−2.551850	0.0113
ECO_GROWTH	0.000320	0.004974	0.064274	0.9488**
POP_GROWTH	0.050084	0.147228	0.340177	0.7340**
IPM	0.161509	0.020903	7.726753	0.0000
INTERNET	−0.004544	0.002607	−1.742740	0.0826

4.3. The Effect of HDI on Electric Energy Consumption

The panel data regression analysis above shows that the t-count for the independent variable Human Growth Index (HDI) is 7.726753, while the t-table value is 1.650735 which means that the t-count is greater than the t-table (7.726753 > 1.650735), besides that, it can also be seen from the probability value that is equal to 0.0000 which is smaller than 0.1 then H0 is rejected. This means that the HDI has a significant effect on energy consumption. The HDI has been related to the availability of energy, since it is known that with a good amount of kWh/inhabitant it will be possible to carry out the activities of daily life in an adequate way, with approximately 4000 kWh/inhabitant (Murillo-Alvarado and Ponce-Ortega, 2022).

4.4. The Effect of Internet Access on Electrical Energy Consumption

The panel data regression analysis above shows that the t-count for the independent variable internet access is −1.742740, while the t-table value is 1.650735 which means that the t-count is greater than the t-table (−1.742740 < −1.650735), besides that, it can also be seen from the probability value that is equal to 0.0826 which is smaller than 0.1 then H0 is rejected. This means that internet access has a negative effect on energy consumption. According to (Qin et al., 2022) states that the panel fixed regression results indicate that after gaining access to the internet, individual electricity consumption declines about 1.2% as the short-run effect (around 2 years). The level of internet development plays a significant negative role on electricity intensity (Hao, 2022).

4.5. Simultaneous Significance Test (Test F)

The F test in Table 2 is used to determine the extent to which the independent variable simultaneously affects the dependent variable and to determine whether the regression model used is correct or not. If the value of F count > F table, then Ho is rejected, it means that the independent variable simultaneously affects the dependent variable. Meanwhile, if F count < F table, then Ho is accepted, which means that there are no independent variables that affect the dependent variable.

The hypothesis is as follows:

H0 = there is no significant influence between the variables of economic growth, population growth, HDI and internet access simultaneously on the consumption of electrical energy.

H1 = there is a significant influence between the variables of economic growth, population growth, HDI and internet access simultaneously on the consumption of electrical energy.

Based on the results of eviews, the calculated F value is 81.06115 while the F table with a level of α = 10%, Df1 = k-1 = 5-1 = 4, Df2 = n-k = 265-5 = 260 is 1.966605. Thus F count > from F table (81.06115 > 1.966605), then also seen from the probability value which is equal to 0.000000 which is smaller than the significance level of 0.1 so that H0 is rejected. This shows that the variables of economic growth, population growth, HDI and internet access together (simultaneously) have a significant effect on electricity consumption, so the regression model can be used to predict the dependent variable.

Table 2: F test results

R-squared	0.554981	Mean dependent variables	0.375403
Adjusted R-squared	0.548134	S.D. dependent variable	0.225160
S.E. of regression	0.151330	Sum squared residual	5.954161
F-statistic	81.06115	Durbin-Watson statistic	1.328890
Prob (F-statistic)	0.000000		

4.6. Coefficient of Determination

The coefficient of determination (Adjusted R-Square) is used to measure a model in explaining the dependent variable. If the Adjusted R-Square value approaches the number one, it means that several independent variables are used to provide information to predict the dependent variable.

The results of the F test in the Table 2, the results of the Adjusted R-Square (R2) are 0.548134. This shows that the percentage of the influence of the independent variable on the dependent variable is 54.81%. This means that the independent variables used in the regression model are able to describe 54.81% of the dependent variable. The rest is influenced by other factors outside the regression model.

Based on the research results, the following conclusions can be drawn: (1) Economic growth does not have a significant effect on electrical energy consumption because economic activity is carried out efficiently so that high economic growth is not necessarily followed by an increase in electricity consumption. (2) Population growth does not have a significant effect on energy consumption. This is because not all populations have access to electric power. (3) HDI has a significant effect on energy consumption. This is because there is a cointegration relationship between HDI and electricity consumption, so when HDI is high, the tendency of people to optimize electricity consumption is also high. (4) Internet access has a negative effect on energy consumption. This is because internet access connected to computers and cell phones is increasingly being balanced with energy savings so that when internet access increases, the consumption of electrical energy decreases.

The suggestions that the author gives to the government and academics are (1) HDI and internet access are 2 variables that affect the consumption of electrical energy. This means that the more educated and better internet access is, the consumption of electrical energy will also increase. So in this case the government needs to immediately apply Renewable Energy (EBT) as a substitute for fossil energy, considering that the potential of this EBT is quite large. The government also needs to implement energy conservation and energy efficiency so that electricity is used wisely. Meanwhile, economic growth and population growth do not affect electricity consumption. This means that there are still some parts of the population who have not been able to access electrical energy so that in the future the government can increase the electrification ratio so that electricity can be enjoyed by all people. (2) For academics who are interested in conducting research with similar themes, it is hoped that this research can be used as a reference. Researchers can also improve the quality of

research with improvements in measurement techniques, use of measuring instruments, research procedures, and other variables considering that there are still many variables that have not been mentioned in this study in order to provide better research results.

5. CONCLUSION

Based on the research results, the following conclusions can be drawn: (1) Economic growth does not have a significant effect on electrical energy consumption because economic activity is carried out efficiently so that high economic growth is not necessarily followed by an increase in electricity consumption. (2) Population growth does not have a significant effect on energy consumption. This is because not all populations have access to electric power. (3) HDI has a significant effect on energy consumption. This is because there is a cointegration relationship between HDI and electricity consumption, so when HDI is high, the tendency of people to optimize electricity consumption is also high. (4) Internet access has a negative effect on energy consumption. This is because internet access connected to computers and cell phones is increasingly being balanced with energy savings so that when internet access increases, the consumption of electrical energy decreases.

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6. ACKNOWLEDGEMENT

I am very grateful to be able to complete this research. Thank you to Nurul Istiqomah as the supervisor. Special thanks to the family who always support me so that this research can be completed.

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